DEVELOPING A PRODUCTION SYSTEM ON IPD: CONSIDERATIONS FOR A PLURALISTIC ENVIRONMENT

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ABSTRACT

As Integrated Project Delivery (IPD) becomes a common method for delivering built infrastructure, the importance of elements such as collaboration, trust, integrated governance and collective decision-making is widely discussed. Questions are raised about how to successfully leverage these elements on integrated projects. This paper suggests seeing an integrated team as a pluralistic network and focusing on principles of pluralistic coordination to align decisions and actions towards an established direction. In pluralistic networks, the traditional hierarchical organization with clear chains of command and a homogeneous community is substituted by a more distributed decision-making process and the project team composed by people with different backgrounds. For people to work together effectively in such environments, coordination is essential. Past research has offered a set of key principles that help achieve such coordination. This paper presents a study that was carried out through action research to support the design of a production system in an integrated project based on those principles. Among the study's outcomes was the establishment of an environment that incentivizes team members sharing and discussing their concerns and expectations, and the alignment of decisions and actions based on what was discussed and agreed by the team. Although the research was limited to only the initial phase of a production system design, an environment that incentivizes open communication to coordinated action was observed. This paper focuses, therefore, on describing the key elements that contributed to establishing such an environment.

KEYWORDS

Integrated Project Delivery, Pluralistic Coordination, Production System Design

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INTRODUCTION

This research was motivated by the identification of a practical problem with theoretical relevance. In 2011, two authors of this paper participated in an effort to improve the decision-making process in the pre-construction phase of project delivered using Integrated Project Delivery (IPD), i.e., an integrated project. The team was facing difficulties to implement decisions by consensus and in a timely manner. The study lasted for one year. A challenge observed in this environment was to achieve a common understanding about project priorities, about why certain decisions were being made, and what would be adequate approaches to solve certain problems.

Participation in that research enabled us to observe an issue that is similar to what has been described in the literature: the challenge of coordinating pluralistic networks. Denning, Flores, and Flores (2011) introduce the term "pluralistic network" referring to environments in which people from different backgrounds can work together effectively. Coordination is essential for people to work together as the lack of adequate coordination can lead to unreliable promises, mismatch in expectations, poor performance, lack of sensitivity, distrust, etc. (Denning et al. 2011). The main cause of coordination breakdowns, as suggested by the authors, is the challenge to deal with different backgrounds, mind-sets, and different sets of values (Denning et al. 2011).

In integrated projects, a diverse team that makes decisions by consensus replaces the traditional hierarchical organization with clear chains of command, so that effective coordination is essential to support action towards an established direction.

This paper presents the results of a case study that was part of an overall effort to improve coordination in pluralistic environments present in integrated projects. The case study described in this paper was the fifth of a series, this one focused on establishing an environment that incentivizes team members to share and discuss their concerns and expectations regarding the production system, and align decisions and actions based on what was discussed and agreed by the team.

The paper is structured as follows. First, we discuss the topic of pluralistic networks and the need for effective coordination. Second, we discuss different expectations that stakeholders might have regarding a production system and the need for making those expectations explicit. Third, we provide an overview of the research method. Last, we offer a discussion of the main findings and our concluding remarks.

PLURALISTIC NETWORKS & IPD

Pluralism has been seen as a political philosophy in which people of different backgrounds, nationalities, cultures, and belief systems commit to living together, respecting their differences, and collaborating to create value for others. Denning et al. (2011) call a network that has assimilated this philosophy a pluralistic network.

Denning et al. (2010) argue that project teams are increasingly virtual, consisting of people in different geographical locations, who have different cultural backgrounds and value systems. In virtual environments (i.e., computer games) people with these characteristics come together in a cooperative effort to achieve a common goal. Denning et al. (2011) suggest that in such pluralistic network settings, the main cause for coordination breakdowns is rather the cultural differences and distinct worldviews, than geographical distance.

Similarly Dennis (2006), in his book *Getting the Right Things Done* which is based on Toyota's practices, explains that the adoption of lean methods and tools are important, however they only form a management system and underlying the management system there is a way of thinking. Lean transformations most often fail because people have different ways of thinking, or as the author calls it: different mental models. A mental model is a person's set of assumptions about how the world works; they affect what we see and what we do. If mental models are not aligned, the lean transformation is unlikely to be successful.

Difficulties of multi-community cooperation are common. Some social scientists have called these "wicked problems" (Kuntz and Snowden, 2003) based on the work of Rittel and Webber (1973): while everyone agrees there is an issue, the various groups cannot agree on a definition of a problem to work on, nor on a strategy for solution. According to Denning et al. (2011), their diverse worldviews add obstacles to coordination and in some situations exacerbate stress.

To flourish in pluralistic environments requires the cultivation of a new kind of pluralism, a mind-set that actively engages with others to articulate shared goals and commit to working together to achieve them. The authors argue that such pluralism requires an "orchestration of commitments in pluralistic networks."

Similar to the computer games environment described by Denning et al. (2011), in IPD projects, the traditional hierarchical organization with clear chains of command and a homogeneous community is substituted by a more distributed decision-making process and a project team that is composed of people with several different backgrounds. Denning et al. (2011) argue that in pluralistic environments, where decisions are more distributed and teams less homogeneous, there is a need for coordination. The differences in perspectives observed in the initial study can lead to value beyond expectations if properly coordinated. In a similar manner, coordination breakdowns in such environments can result in unmet expectations, disagreements and poor performance.

Denning et al. (2011) then suggest a set of desired skills to successfully coordinate a pluralistic environment:

1. Use language as action to effectively make and coordinate commitments that add value to others.
2. Build trust with others by cultivating the ability to make assessments that facilitate taking care of each other's concerns.
3. Listen for opportunities to bring value to others.
4. Observe and bring to the foreground underlying moods that may help or hinder the ability to act with and listen to others.
5. Respect people's differences.
6. Build strong, effective teams based on the above.

EXPECTATIONS WHEN DESIGNING A PRODUCTION SYSTEM

Ballard et al. (2001) explain that the first task in any productive endeavor is production system design, which extends from global organization to the design of operations, e.g., from decisions regarding who is to be involved in what roles to decisions regarding how the physical work will be accomplished.

In lean construction, production systems are designed to achieve the purposes of both their customers and those who "deliver" the system, the producers. Those

purposes may vary greatly, but producers, in their role as "guardians" of the production system, have goals that are appropriate for all such purposes, i.e., maximize value and minimize waste (Ballard et al. 2001).

However, while the goals of maximizing value and minimizing waste might be clear, what does "generating value" mean in the context of production system design? Emmit and Christoffersen (2009) illustrate that value can be perceived not only by those assessing the final product, i.e., beauty, functionality, durability, suitability for the site and community, sustainability; but also by those undertaking the construction effort, i.e., work ethics, communication, conflict resolution, and trust.

Values can be understood as "desirable states, objects, goals, or behaviors transcending specific situations and applied as normative standards to judge and to choose among alternative modes of behavior" (Schwartz and Bilsky, 1987). This definition highlights two important functions of values. First, they can provide coherence and sense of purpose to an individual's behavior, as they transcend specific situations. Second, because they are normative standards, values are a basis for generating behaviors that conform to the needs of groups or larger social units. Lord and Brown (2001) stress the importance of "socializing a particular set of values" as a means to free individuals from direct social control, while ensuring that they will exhibit behaviors that are compatible with group needs.

Talking about different individuals values is particularly important in an integrated team environment, in which the range of participants include not only professionals with different technical backgrounds but also a blend of people involved in pre-planning activities (e.g., project executives, BIM coordinators) and those involved in supervising field activity (e.g., superintendents, foremen). Discussing the different expectations regarding a production system and articulating an agreed vision based on the team's values can set the basis for an environment in which team members are committed to add value to each other throughout project execution (Denning et al. 2010).

RESEARCH METHOD

The authors chose to study the contributions of pluralistic coordination principles to supporting the design of a production system in an integrated project by using action research. Because the practice of production system design in integrated projects is still developing and because implementation of pluralistic coordination principles would require participation and exploration by all members of the project team (Greenwood et al. 1993), it was decided that action research was the most appropriate methodology to use for research of this nature.

Action research can be focused on a single project, but differs from more familiar case study research in that "the researcher is not an independent observer, but becomes a participant, and the process of change becomes the subject of research" (Benbasat et al. 1987, Westbrook 1995).

The project started in 2005, using an Integrated Form of Agreement (IFOA). The IFOA supports risk sharing and individual parties identify their own interests with those of the project (Koskela et al. 2006). To incentivize collaboration, the IPD team was co-located on one office floor since the beginning of the project. Also, to improve alignment among team members and support the adoption of lean practices,

extensive training on lean construction and IPD principles was provided for team members throughout project duration.

In late 2011, the project was suspended. This study was carried out during the first three months of the project re-start and re-organization. One of the first actions undertaken by the IPD team in the re-start period was to establish a production team. The team was organized by the project's production leader (working for one of the two general contractor firms in the joint venture) and comprised representatives of both general contractor firms in the joint venture, as well as representatives from trade partners that were highly interdependent in their scope of work, e.g., mechanical-, plumbing-, electrical-, and drywall systems. Team members included project executives from the joint venture, project managers from the different companies, project engineers, the general superintendent, the MEP superintendent, trade specific superintendents, foremen, and BIM coordinators. The production team met once a week for 2 hours to design the production system based on lean principles to facilitate the realization of all interdependent building systems.

The focus of the action research was to establish an environment that incentivizes team members sharing and discussing their concerns and expectations regarding the production system, and aligning decisions and actions based on what was discussed and agreed by the team. During the study, the researcher and the production leader would discuss the intended result of each exercise with the rest of the team. The techniques used to achieve such were based on the team's discussion.

RESEARCH FINDINGS

LISTENING TO INDIVIDUAL CONCERNS AND EXPECTATIONS

The first production team meeting took place in September. Attendees were required to come prepared to discuss their expectations regarding the design of the production system, in other words, aspects they considered important to achieving success. 18 participants attended the meeting, contributing 49 different aspects that were discussed in the meeting.

The team leader went around the table and asked each participant to contribute their thoughts. The answers were based on what each participant thought was important for a production system. Some answers were complementary, meaning that some team members would use their turn to add aspects that had not yet been mentioned. Thus, the different comments did not necessarily represent that team members had conflicting perspectives, but rather that the statements were made in a complementary manner. Those comments were analysed and some categories identified (Table 1).

Table 1: Sharing expectations about the production system

	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8	Participant 9	Participant 10	Participant 11	Participant 12	Participant 13	Participant 14	Participant 15	Participant 16	Participant 17	
Team's / Crews' morale	1				1			1	1					1	1			**6**
Built-in quality	1	1				1		1			1							**5**
Innovation	1		1	1			1									1		**5**
Reliable workflow		1	1									1				1		**4**
Trust / Mutual respect			1		1							1				1		**4**
Securing profit		1										1		1				**3**
Clear goals / targets			1		1			1										**3**
Constructability			1							1							1	**3**
No rework	1			1														**2**
Teamwork	1											1						**2**
Monitoring and control								1									1	**2**
Right equipment tools information									1						1			**2**
Safety													1		1			**2**
Design Quality / Coordination										1								**1**
Pre-fabrication													1					**1**
Trailblazer														1				**1**

Different types of expectations regarding the production system were observed with this exercise. Those included not only technical (e.g., built-in-quality, constructability, no rework) but also behavioral components (team morale, mutual respect, trust). It was also observed that the expectations were formed as a consequence of different facts: (a) participants' familiarity with lean due to a project focus on lean practices and innovation supported by training provided since the beginning of the project; (b) individual lessons learned and previous experiences, and (c) role-based specific concerns.

In the following week, the team agreed to carry out an exercise to search for similarities and differences in the expectations. For that, a "cloud exercise" was carried out. This process allowed the revision of the individual statements in a team environment, the creation of a shared understanding of each statement's meaning, and the reaching of agreement on the different categories to be considered. The statements were printed on small pieces of paper and placed on the board based on similarity. The approach to place the paper would be followed by a team discussion and agreement on similarities and differences among the different statements. The author of the statement would clarify to the team the meaning of it. A discussion about the topic and its description would follow. The clouds were constructed, deconstructed, re-arranged, until all participants agreed on what appeared on the board. Figure 1 shows the result of this exercise.

Figure 1: The cloud exercise to find categories

The categories agreed upon by the team were: (a) support the workers, (b) transparency, (c) cost, (d) innovation, (d) trailblazer / raise the bar, (e) quality, (f) safety, (g) incentives, (h) positive attitude/trust, and (i) flow. Each category emerged after a long discussion process. The word "trailblazer", for instance, emerged from a discussion on innovation: the desire to challenge status quo and achieve a level of excellence that would set new standards for the industry. Such culture, reflected in participants' expectations, was established in this project from the beginning, as this was a pioneer project in the adoption of lean principles and IPD in the US.

The process of undertaking this exercise was found particularly valuable for team members to learn about each other's expectations, to review the vision that was set out by those that were involved in the project prior to suspension, and to agree on what this new team (with new team members joining after the project re-start) wanted to accomplish.

The team also observed that a blend of means and outcomes were mixed in the different statements. That was the motivation to take a next step: identifying and separating means from outcomes. As the vision was defined, the need to discuss how to get there was identified.

IDENTIFYING MEANS AND OUTCOMES

The next exercise, and perhaps the most important one the team carried out was the analysis of means and outcomes. This exercise was carried out in a series of workshops to identify and distinguish the desired outcomes and understand the contributing factors to achieve those outcomes. The result of the cloud exercise was organized on a diagram developed by one of the team members. The diagram resembled the roots of a tree and during a workshop the team decided to adopt a tree metaphor to help visualize the separation of means and outcomes.

The team discussed the contents of the diagram, refining the statements and defining the ultimate outcomes expected from the production system being designed. Figure 5 shows a draft version of the tree diagram developed by the team.

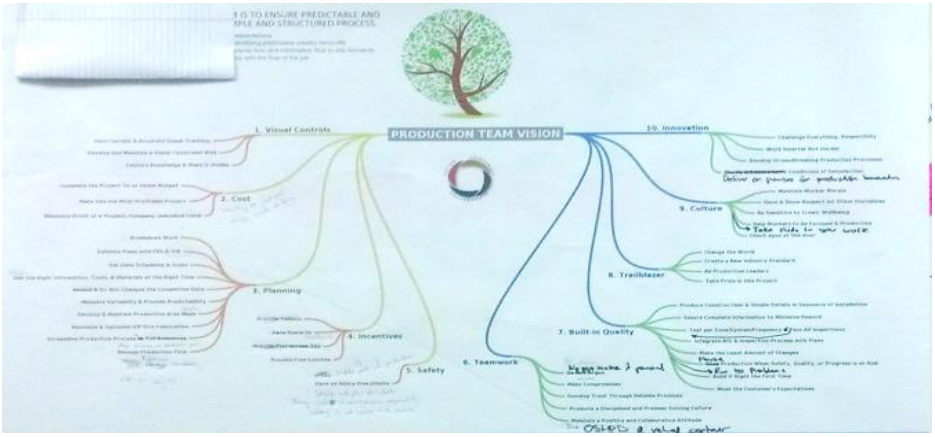

Figure 2: The tree exercise to identify means and outcomes

MISSION STATEMENT

Once the expected outcomes were clearer, the team decided to develop a mission statement, based on that shared vision. Participants wrote down their thoughts on the board: "Empower everyone for safety," "Build as proud craftsman", "Innovation is rewarded", "Respect the work of others", "Building a place for care" (Figure 3).

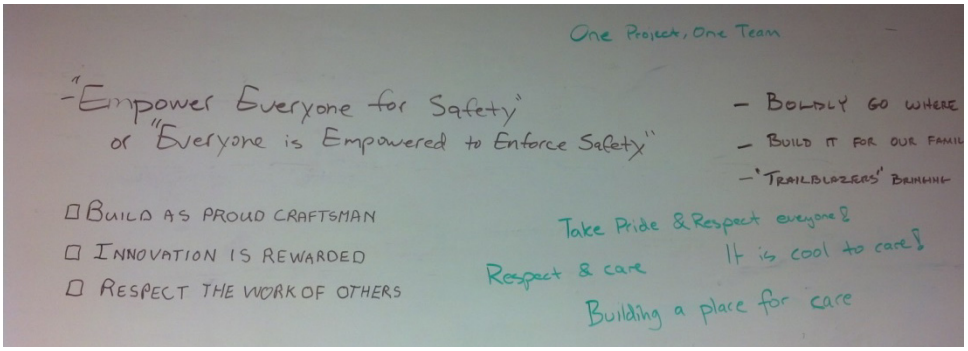

Figure 3: Defining the team's mission

The statements were further refined and discussed by the team. Figure 4 shows the end result. At the top are the values that express the team's mission; underneath it, is the mission statement; and at the bottom, the means that the team believes will contribute to achieving their mission.

Another aspect discussed by the team was the intent to take the mission statement to the field crews as a way to build a similar culture established during the pre-construction period. Figure 4 shows the final categories identified: desired outcomes and means the team believes will lead to those outcomes. Developing strategies that will contribute to achieve those means became part of the planning activity.

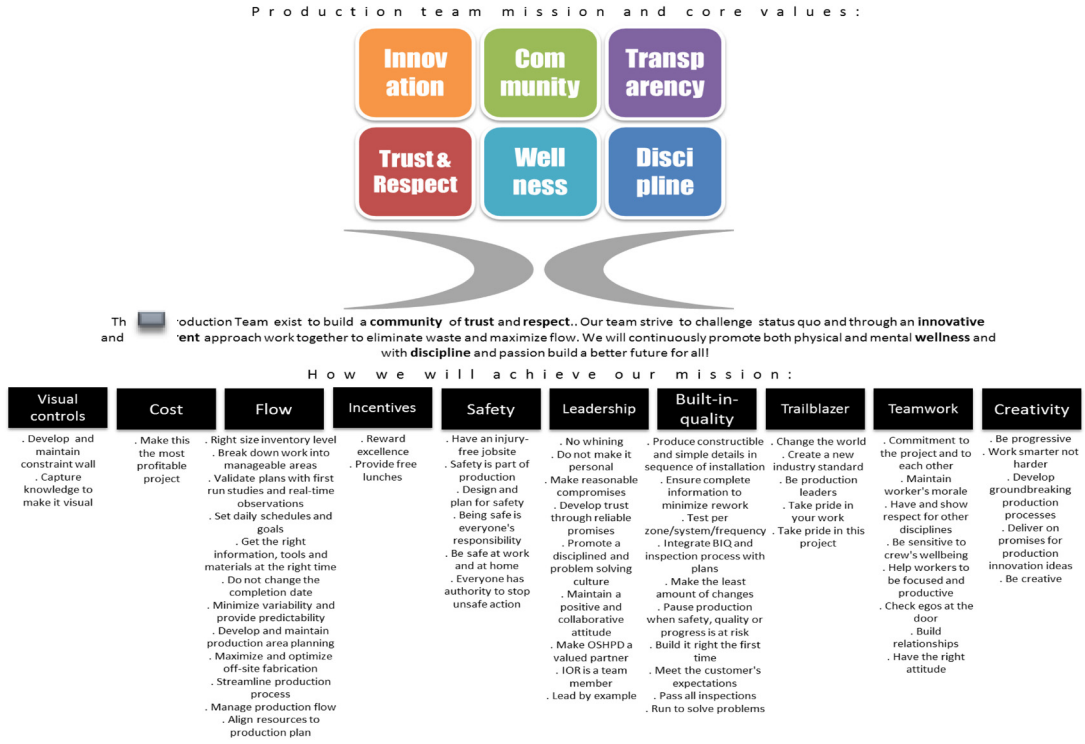

Figure 4: Final vision with means and outcomes

THE PRODUCTION IMPROVEMENT IDEAS LOG

The project had a log to collect ideas for the production system called "the Production Improvement Ideas or Pii Log," which was built over time. The log was devised to record ideas coming from the production team and other team members regarding the production system. All team members had access to it and could add their input to the log. Those ideas were analyze by top management and estimators and approved by consensus. The team constantly revised the log, adding items as new ideas emerges. In October, the log had 103 items, which were analyzed and compared to the values stated in the exercise. This analysis helped to verify the congruence between the vision articulated by the team and the decisions being made during the actual design of the production system. Ideas to improve flow and efficiency during construction, built-in-quality, teamwork and collaboration, focus on visual management, incentives and workers wellbeing were the predominant categories observed in the log (Figure 5).

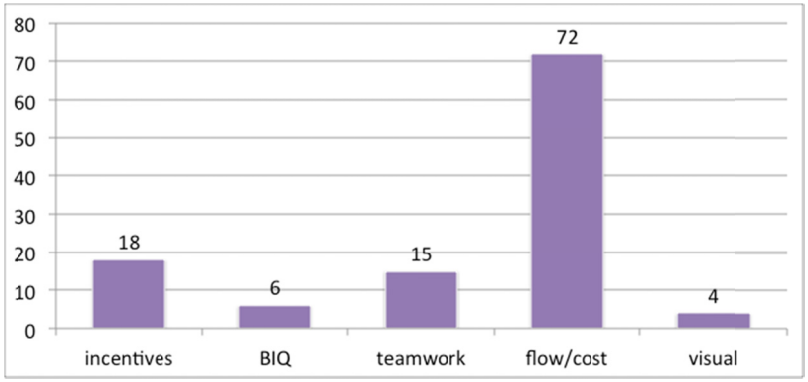

Figure 5: Distribution of ideas by category

DECISIONS BASED ON THE VISION

During subsequent meetings, which followed the exercise of articulating a vision, it was observed that the team would recall the tree exercise and judge the decisions being made about the production system based on the expectations that had been discussed. One example was that the team evaluated alternatives based whether or not they would help the trades achieve flow during the installation process, a strong component of the vision. Another example was that the team discussed strategies to engage the field crews in training and how to support their participation in improving the construction process.

DISCUSSION

During this study we observed the development of some characteristics that are associated with key skills for effective pluralistic coordination as defined by Denning et al. (2011). Those characteristics and what contributed to their achievement are:

- *Use language as action to effectively make and coordinate commitments that add value to others*

The exercise of building a shared vision was the starting point to create collective awareness of the team's expectations regarding the production system. Breaking down outcomes and means then supported the team to visualize what actions would contribute to achieve the desired vision. This was a starting point to enable an environment in which team members can act towards adding value to others.

Even though it is hard to achieve a complete list of expectations, team members benefited from having an initial set of criteria regarding the production system to discuss about. Perhaps the interest of working in the same direction was always there, however, the conversations about those expectations rarely happen in construction projects.

- *Build trust with others by cultivating the ability to make assessments that facilitate taking care of each other's concerns*

Concerns and possible solutions were discussed throughout the workshops. The exchange of experience about past practices and challenges was a valuable knowledge sharing exercise about potential problems and possible solutions. Team members concerns were discussed, as well as how to mitigate or avoid them. Visits to previous job sites were also carried out, in which team member would exemplify how they have solved specific problems before.

It was also observed that the communication within the production team was very open and honest. A high level of participation from all team members as well as their willingness to exchange experiences and help each other was observed.

- *Listen for opportunities to bring value to others and respect people's differences*

Every opinion was considered and discussed. The importance of listening to everybody's concern was an aspect emphasized from the beginning of this research and helped to achieve an environment of open and honest communication.

- *Observe and bring to the foreground underlying moods that may help or hinder the ability to act with and listen to others*

During the discussions it was observed that the team was establishing a common mental model about the desired behaviors. This common understanding was also a result of extensive training in lean construction that some of the team members received since the start of this project. New team members benefited from this discussion and understood the importance of being aligned and extending the same mental model to the field crews.

Some elements of this action research seemed to have contributed to leveraging the aforementioned characteristics, namely:

- A project with contractual relationships that incentivizes different parties to work together;
- A project with focus on innovation and lean implementation;
- Possibility to have weekly meetings (2 hour duration) to talk about the production system (enabled by a team that is collocated);
- A team leader from the GC side who stimulated everyone to share their individual opinions and listen to each others' concerns (this element was key to incentivize participation and have trade partner's and field supervision's input);
- An external researcher who contributed to establishing an environment of open and honest discussions; and
- Discussion about the intent of the exercises and team participation on developing and deciding which techniques to use.

CONCLUSIONS

The intent of this study was to advance our understanding on how to achieve effective coordination on IPD projects. In this paper we described the observed benefits of managing the diverse perspectives of team members who are involved in designing a production system and work in a pluralistic network setting. The team member's attention was focused on discussing each other's concerns and exploring the means to achieve expected results. Decisions were better aligned with what the team stated as important during the workshops. Such conversation was carried out in an inclusive manner, which contributed to establishing the desired environment to support open and honest communication. However, whereas we could observe some positive outcomes of this study for the production team, further research is necessary to understand how these contributions could be extended to the entire IPD team.

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